Epping NH & Newmarket NH

Adventures in Energy

Concepts & Thoughts

Outside the

- Distributed.
- As a lead.
- Myriad.
- New technologies.

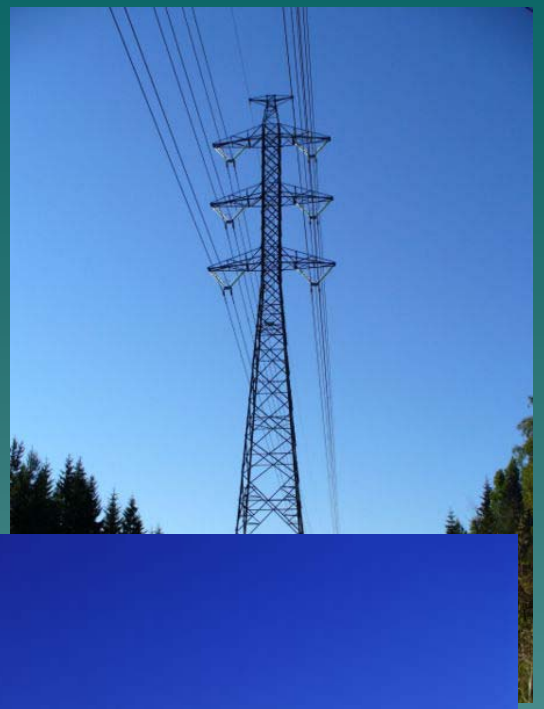
Box

- "Without new investment in power infrastructure and greater energy efficiency and conservation, New England could soon be consuming more electricity than it can produce or buy from its neighbors," said Stephen Whitley, ISO New England's chief operating officer.
- Boston Globe 4/26/06

The Learning Curve

Distributed Generation

- Moving away from centralized plants.
  - Waste Heat.
  - Transmission Loss.
  - Pollution.
- Security.
  - Onsite backup.
  - National targets.
- One world.
  - Pollution.
  - Renewables and Fuel Diversity.



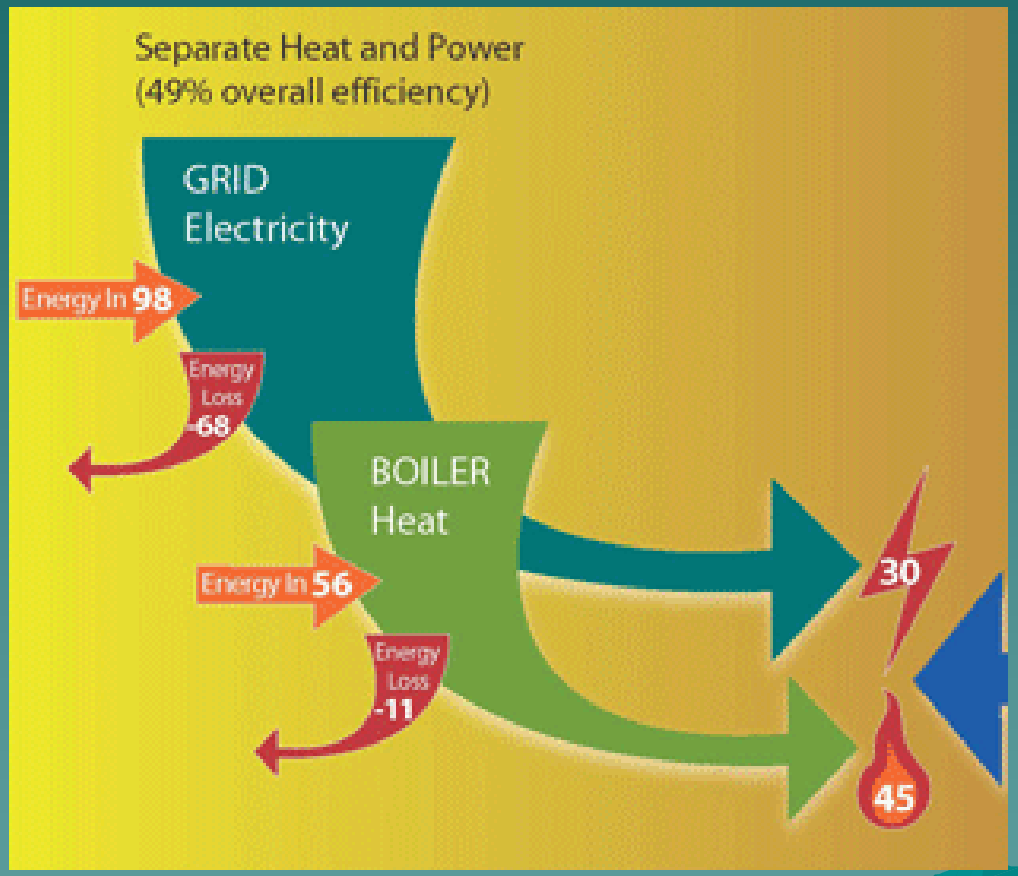
What we discovered.

- Cost savings.
  - Lower Taxes.
- Economic edge.
  - Economic Development.
  - Innovative and willing to partner.
- New Projects on line.
  - $35 Million School.
  - New water source.
  - New treatment plant.
- Frustration leads to Freedom
- Municipal Role.
  - As Customer.
  - As Public Benefactor.
  - As Utility.
- Why not?

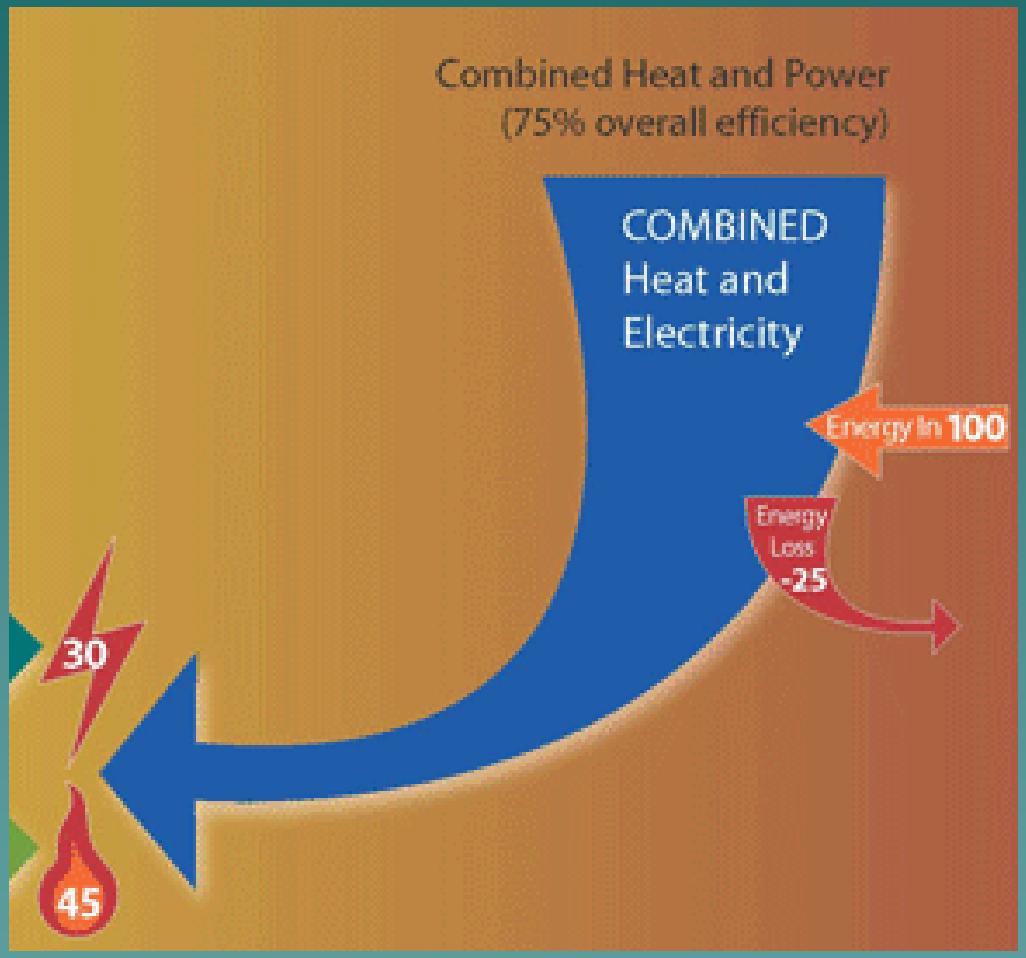
Results

- Ultimate goal.
  - Municipal Utility.
  - 27 MW.
    - 2 Hydro – existing dams.
    - Wind.
    - 400,000 sq ft (PV)
    - CHP turbines.
  - $27 million.
  - Cost/taxpayer = $0
  - 60,000 tons / yr.
    - 24,000 cars.
- First stage.
  - WWTP CHP
  - Use Methane
    - Renewable
    - Cleaner burn
    - Free
  - Current
    - $85,000/yr/elec.
    - $35,000/yr/oil.
  - Projected:
    - $35,000/yr/elec.
    - $10,000/yr/propane.
    - 2 year payback.

Conventional

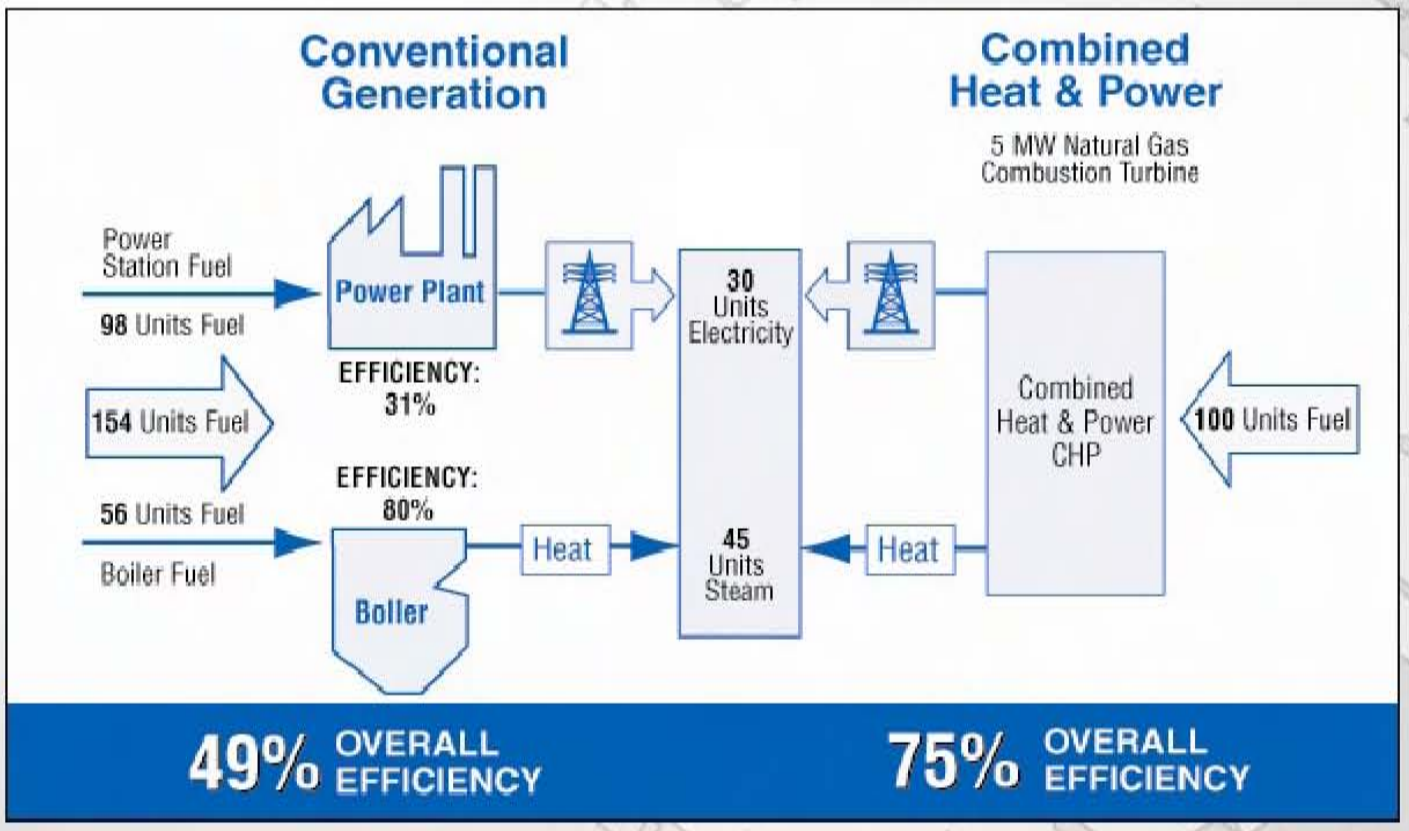


Combined Heat & Power



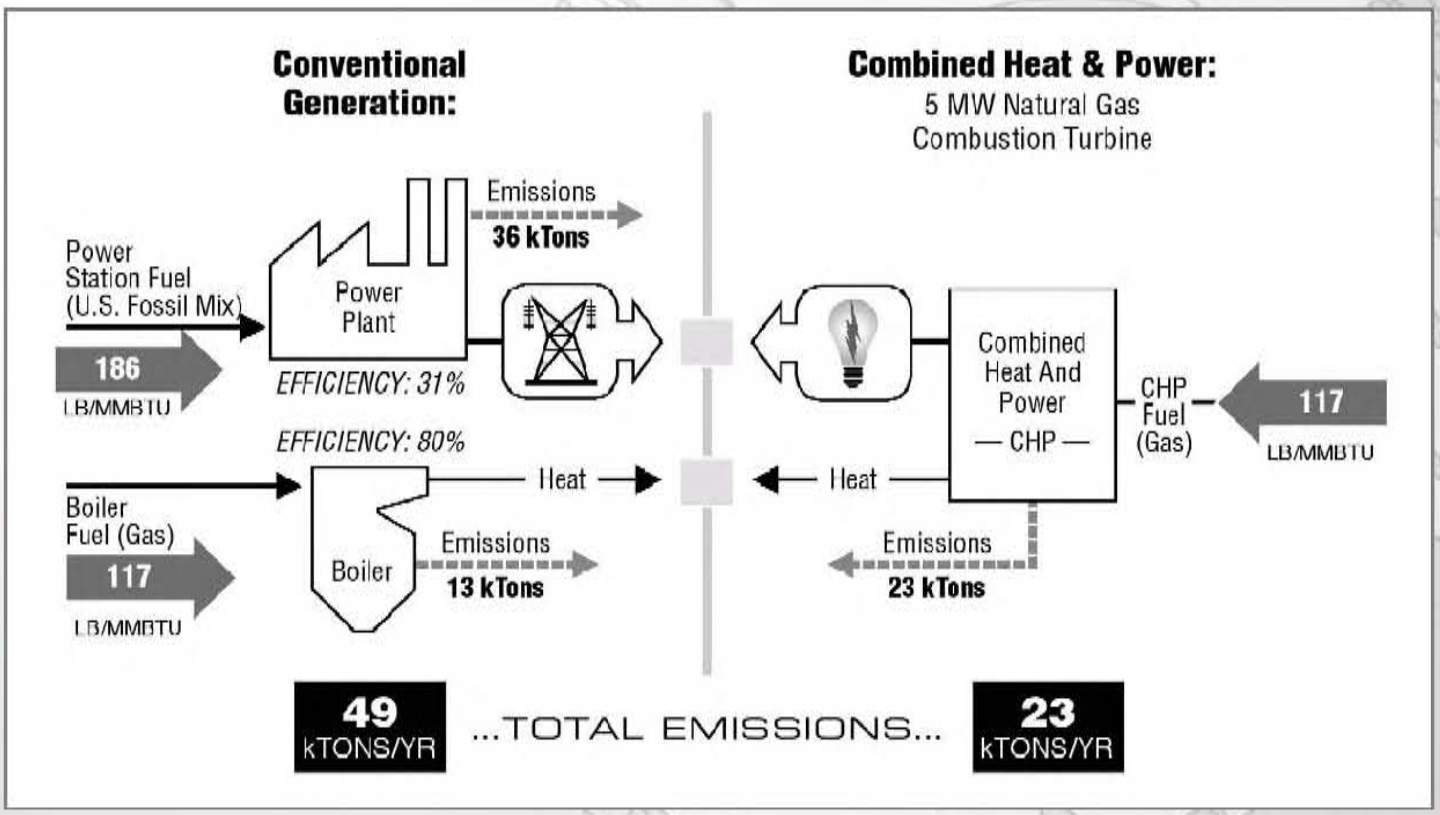
-or-

Efficiency Advantages of CHP



CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

Environmental Benefits of CHP- CO_2 Example



CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

Pollution

Table 4.1 Emission Rates from Relevant Generation Technologies

Emissions	NOx (lb/MWh)	SO_2 (lb/MWh)	CO_2 (lb/MWh)
PEM	0.06-0.1	negligible	1170-1360
SOFC	0.05	negligible	910
MT natural gas	0.45-1.25	negligible	1500-1750
MT biodiesel	1.2	negligible	330
Gas-Fired Lean Burn IC Engine	2.2	negligible	1108
Biodiesel	29	negligible	330
Diesel Engine	26	3	1500
Wood Steam Plant	1.5	0.3	0
Diesel Engine	4.7-21.8	0.45	1432
Coal Power	5.6	13.4	2115
Average Fossil Power	5.1	11.6	2031

CHP → Required Output ← Conventional

Gas Input
0.972mmBtu/hr
17.7scfm

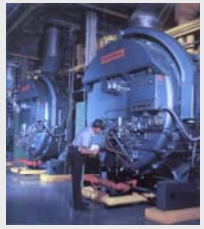
Gas Energy
0.972mmBtu/hr
Basic Rate $11/mmBtu
=**$10.69**

80 kW Electrical

0.477mmBTU
Heat

Grid
Electrical Energy **80kWhr**
Basic Rate 12c/KWhr
=**$9.60/hr**

Boiler 80% Efficient



Gas Input
0.596mmBtu/hr
10.8scfm

Gas Energy **0.596 scfm**
Basic Rate $11/mmBtu
=**$6.556/hr**

Costs	**CHP**	**Conventional**
Gas	$10.69/hr	$6.56/hr
Electricity	N/A	$9.60/hr
	$10.69/hr	$16.16/hr

Saving with CHP = **$5.47/hr**
@ 5000hr/yr = $27 350/yr
@ 8000hr/yr = $43 760/yr

Conventional					
	80	0.15	12		
	0.596	13	7.748		
			19.748		
CHP					Savings/hr
	0.972	13	12.636	Hrs/yr	$7.11
	0	0	0	5000	$35,560.00
			12.636	8000	$56,896.00

Heat?

- Heat.
- Cool.
- Both/Same time.
- Evaporation Dehumidification.
- Water.
- Steam.
- Air.
- Grocery.
- Bakery.
- Cold storage.
- Living space.
- Ice rink.
- Swimming pool.
- Manufacturing.

Waste-Water Plant

Ingersoll-Rand
Energy Systems

Case

Western Lake Superior
Sanitary District (WLSSD)
Digester Gas-to-Energy
Two MT70L Microturbines

WLSSD Wastewater Treatment Plant

MT70L Microturbines

IR Fuel Conditioning System

For more information about Ingersoll-Rand Microturbines and Industrial Standby Generators, please contact IR Energy Systems or visit www.irenergysystems.com

Published November 2004

Site

Western Lake Superior Sanitary District
Regional Wastewater Treatment Plant
Duluth, Minnesota USA

Digester Gas-to-Energy Project
Commissioned February 2004

Background

The Western Lake Superior Sanitary District serves as the wastewater and solid waste authority within a 530 square mile region in northeastern Minnesota. The regional wastewater treatment plant has been operating its Anaerobic Digestion Facility since 2001. The facility breaks down sludge into biosolids for use as fertilizer, and biogas for use as fuel.

WLSSD is known throughout the industry for its leadership in implementing innovative solutions to environmental problems. With a vision to make its original anaerobic digestion project even more environmentally friendly, WLSSD partnered with Minnesota Power and the Minnesota Department of Commerce to develop a project that would use the waste methane to produce clean electrical and thermal energy.

Collaboration between WLSSD, the Department of Commerce and Minnesota Power led to the approval of a $307,000 Minnesota Power Conservation Improvement Program grant to be used for the green power pilot study at the facility.

Application

WLSSD contracted Siemens Building Technologies, already performing a district-wide energy review, to engineer and develop the green power project at the facility. Microturbines were chosen as the preferred technology because of their ability to burn low Btu gas more efficiently and with lower exhaust emissions and operating costs than reciprocating generator sets.

However, microturbines are not the only new technology demonstrated at this facility. Raw wastewater digester gas requires treatment to remove moisture and siloxanes, a substance found in cosmetics and shampoos, prior to combustion in the microturbine. Because Ingersoll-Rand was able to offer a complete waste gas-to-energy solution, Siemens chose IR's innovative fuel conditioning technology and microturbines for the project.

Ingersoll-Rand uses a proprietary technology to deep chill the gas, removing virtually all of the siloxanes, as well as other harmful contaminants. This same process removes moisture and compresses the biogas for reliable operation.

The microturbine project was sized for continuous operation, generating 100% of the electricity required to operate the Anaerobic Digestion Facility, without the need to export power. The offset of purchased electrical power, combined with natural gas savings from the use of co-generated hot water for space heat, would help WLSSD achieve the best return on the investment. The ability to demonstrate a reasonable financial payback was a project requirement.

The IR microturbines currently receive approximately 50scfm of the available 300scfm stream of digester gas. The balance of the gas stream is used in a methane-fired boiler to heat the digesters. Integration of the microturbines and fuel conditioning system into the facility was fairly simple due to substantial available space, available utility hookups, and proximity to the fuel source.

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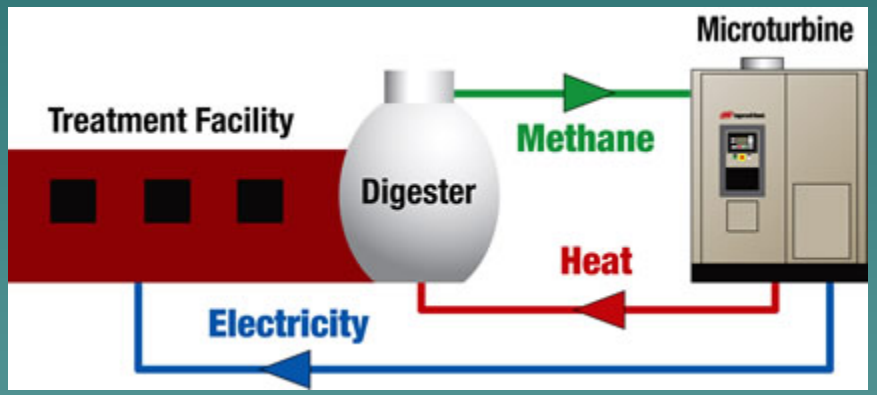


NORTHEAST CHP APPLICATION CENTER

combined heat & power in wastewater treatment

Essex Junction WWTF

60 kW CHP Application

Project Profile

The MicoGen heat recovery system

Quick Facts

Location:
Essex Junction, Vermont

Installation Date:
October 2003

CHP Equipment:
Two 30-kW dual-fuel Capstone C-30 Micro-turbines
MicoGen MG2C2 heat Recovery system

Type of Fuel:
Self-generated methane gas; natural gas

Winter and Summer Heat Recovery Application:
Heating of anaerobic digester (process)

System Efficiency:
> 80%

Annual Energy Savings:
412,000 kWh per year (36%)

Project Cost:
$303,000

Simple Payback:
7 years

Project Overview

Until 2003, the Essex Junction wastewater treatment facility used half the waste methane gas produced by its anaerobic digester to fire the boiler that heated the digester. (Anaerobic digestion stabilizes wastewater sludge, reduces sludge volume, and eliminates pathogens.) The remaining waste methane gas was flared, because methane is a greenhouse gas that is 20 times as effective at trapping heat as carbon dioxide, the gas produced when methane is burned.

Although facility officials had been interested in combined heat and power since 1992, high initial costs failed to satisfy the requirement of the facility's governing board, that all projects have a simple payback of no more than seven years. Furthermore, it was unclear whether sufficient digester temperatures could be maintained when methane was used to fire a CHP system. The system was also required to emit no more pollutants than flaring methane did.

In order to satisfy the payback period requirement, the facility was able to obtain additional funding from Efficiency Vermont, The Biomass Energy Resource Center, NativeEnergy and the U.S. Department of Energy. While the local utility was supportive of the project, it was unable to offer financial support.

Essex Junction used Northern Power to design its system, which uses micro-turbines that can run on either methane or natural gas. The fuel system runs the two fuels in parallel, but methane gas is the priority fuel. Natural gas can be added, in continuously variable blends, through a mixing control valve.

"Northern Power Systems has developed a customized a control system that has worked very well and reliably for us," said James L. Jutras, Director Public Works/Wastewater Treatment.

Dual alternating CompAir V07G compressors

Energy Overview

The facility pays an average price of electricity per kilowatt-hour of approximately 10 cents to the local utility. Before cogeneration, electric use was 1.1 million kWh per year and cost approximately $100,000. That cost has dropped by $37,000, or about 36 percent.

The facility produces an average of 30,300 cubic feet of methane per day, with a typical energy content of 520 BTU per cubic foot. Although it was initially envisioned that two 30 kW micro turbines would operate an average of 40 total hours per day, methane generation since startup in October of 2003 has been sufficient to run the micro turbines for 48 total hours each day. The extra eight hours represent more than 80,000 kWh of electricity per year.

On-peak demand has dropped from the range of 134-235 kW to the range of 110-215 kW; off-peak demand from 130-226 kW to 94-226 kW; average use from 93,000 kWh to 61,000 kWh.

Challenges

After the CHP system was installed, the power factor has dropped from 96 to 87. An investigation revealed that because the CHP system produces only real – rather than reactive - power, it changes the dynamics of the site grid. Plant officials are still studying the problem, Jutras said.

Also, because the digester methane gas is saturated with water, maintenance on the methane compressors has proven to be more difficult and costly than anticipated. The facility is upgrading its equipment, to maximize moisture removal. Officials hope this will significantly reduce the potential for further moisture problems.

Awards

The Essex Junction CHP installation was awarded a 2003 Vermont Governor's Award for Environmental Excellence and Pollution Prevention. Projects are chosen for their innovative approach, economic efficiency, and their ability to serve as a model for others.

While methane-based cogeneration is more common at large wastewater facilities, it is not considered cost-effective for small facilities like Essex Junction, whose daily average flow is 2 million gallons per day. It is estimated that between 5% and 15% of the nation's 16,000 wastewater facilities could implement similar projects.

Benefits

- Saves $37,000 in electricity costs (36% per year)
- Prevents power plant carbon dioxide emissions of 600,000 pounds
- Uses nearly 100% of its waste methane, a renewable fuel, compared to 50% before
- Demonstrated the viability of methane-fired cogeneration at a small facility
- Relieved transmission & distribution constraints on the grid

For Further Information Contact:
Beka Kosanovic
Northeast CHP Application Center
University of Massachusetts
Amherst, MA 01003-9265

Phone: 413-545-0684
Fax: 413-545-1027
www.northeastchp.org

"The Essex Junction CHP installation is proof that small scale CHP retrofits are viable and cost effective."

James L. Jutras, Director, Public Works/ Wastewater Treatment, Village of Essex Junction

Farms


CVPS
COW
POWER
HOME | HOW ENERGY HAPPENS | OUR FARMS | NEWS | ENROLL | ENVIRONMENT | FAQs
providing renewable energy one cow at a time
Green Mountain Dairy
Green Mountain Dairy Farm is expected to be online by February, 2007.
Location: Sheldon, Vermont
History: Owners Brian and Bill Rowell grew up on a farm in Albany, Vt. Brian's family owns Green Mountain Forest Products in Sheldon. Ten years ago, Brian decided to go back into farming, and started up Green Mountain Dairy. The barns seen here were built from scratch in 1999.
Cows: 1,050 milking
Production: The farm produces over 20 million pounds of milk a year, and is estimated to produce 1,828,000 KWH (kilowatt-hours) of electricity a year.
Our Farms
Blue Spruce Farm
Green Mountain Dairy
Montagne Farms
Newmont Farms LLC
Deer Flats Farm
Berkshire Cow Power LLC
Buy an Energy Happens T-shirt
CVPS Home | Copyright 2006 Central Vermont Public Service | 77 Grove St., Rutland, Vt. 05701 | Customer Information 800-649-2877 | Contact Cow Power

$250,000.00

$150,000.00

Schools

:: PureCell™ Solution :: PureComfort™ Solution :: PureCycle® Solution :: PureMotion™ Solution

The **East Hartford Hornets** are **Buzzing** with the

Latest Energy Efficient Technology from **UTC Power**

Cooling, Heating and Power

Education / Health Care / Hospitality / Manufacturing / Municipal / Office / Retail / Mass Transit / Special

super-efficient

reliable

clean

energy-saving

alternatives

the future is here

Educating and sheltering their community

"The PureComfort™ solution is very reliable, provides clean energy and operates very efficiently. After suffering a catastrophic loss to our power and cooling plants, we turned to a trusted leader in the industry, UTC Power. We also look forward to installing a PureComfort™ system at our middle school."

Albert Costa, Director of Facilities
East Hartford School District

UTC Power's super-efficient, ultra-low emission PureComfort™ 240M solution provides cooling, heating and on-site power for East Hartford High School. The system also provides back-up power in the event of an emergency – allowing the school to qualify as an emergency shelter. Efficiency gains and back-up power benefits ensure significant cost savings for the school as well.

The PureComfort™ 240M solution is a combination of a double-effect absorption chiller from Carrier Corporation, UTC Power's sister company, and four 60 kW microturbines. It is the industry's first integrated microturbine and double-effect absorption chiller energy solution.

Project Profile:

Equipment:	PureComfort™ 240M Combined Cooling, Heating and Power solution
Commissioned:	June 30, 2006
Location:	East Hartford, Connecticut
Provides:	Power for electrical needs Back-up power Space cooling Space heating

Total Estimated Output	
Cooling	120 RT
Thermal	1,100 MBH
Electrical	240 kW

Total System Efficiency
~80% @ ISO conditions

:: Power Security

The PureComfort™ solution is designed to operate in parallel to and independently from the grid. With back-up power available within minutes, the system provides safety and security to the students and the community.

:: Energy Efficiency

The exhaust heat from the natural gas powered microturbines is collected in a manifold and used to

UTC Power
A United Technologies Company

:: PureCell™ Solution :: PureComfort™ Solution :: PureCycle® Solution :: PureMotion™ Solution

Education / Health Care / Hospitality / Manufacturing / Municipal / Office / Retail / Mass Transit / Special

PureComfort™ Solution Features:

Energy efficiency
- *Reduce overall energy spending*
- *System efficiencies up to 90%*
- *Simultaneous heating and cooling*

Reliable power
- *Dual-mode option (grid-connect, grid-independent)*
- *High availability*
- *Remote monitoring service available 24/7 worldwide*

Clean power
- *Ultra-low emissions*
- *No ozone-depleting fluorocarbons*
- *Low maintenance*
  - few moving parts
  - innovative design

Pre-engineered solutions
- *Indoor/outdoor siting flexibility*
- *Lower costs*
- *Shorter lead times*
- *No seasonal changeover*

directly drive the double-effect absorption chiller, enabling the PureComfort™ 240M solution to achieve an overall fuel utilization of more than 80 percent, far greater than the 33 percent typical of a central power plant providing grid power. With an efficiency more than twice that of traditional power sources, the PureComfort™ solution ensures that East Hartford High School is conserving energy and saving money.

The PureComfort™ solution installed at East Hartford High School provides up to 120 RT of space cooling or up to 1,100 MBHs of space heating and up to 240 kW of power year round. This solution provides heating and cooling simultaneously and is able to maximize its efficiency by using partial heating and cooling throughout the year.

:: Environmentally Responsible

This PureComfort™ solution impacts the environment in a significant and positive way. It reduces NOx emissions equivalent to removing 170 cars* from the roadways per year. In addition, the system saves enough electricity to light 200 homes and creates the same environmental benefits as planting 90 acres** of forest. This product illustrates East Hartford High School's and UTC Power's commitment to a cleaner world environment.

As of July 2006, the UTC Power fleet of commercial products has accumulated more than 1.2 billion kilowatt hours of operation.

Compared to the average US power plant emissions (Ref: 2002 data, US EPA, DOE/Energy Information Administration)
** Each car assumed to generate 38 lbs NOx/year (Ref: US EPA)*
*** Each acre of forest assumed to absorb 1.3 tons Carbon/acre/year (Ref: International Panel on Climate Change)*

P216 - R062306

UTC Power
A United Technologies Company

1.866.000.POWER www.utcpower.com

$200,000.00

$ 75,000.00

Schools

Canton City Schools
C. T. Branin Natatorium Microturbine Project

Canton City Schools
C. T. Branin Natatorium Microturbine Project

- System Features
- Microturbines- Two 28kw Capstones
  - Operate on 4 oz natural gas fuel pressure
  - Multi-Pac Operation (Multiple-units operate as one)
  - Grid Connect & Stand-Alone Operation
    - Stand Alone provides lighting for 1/3 of Pool area
  - NOX Emissions- Less than 9 ppm @ 15% O2,
    - Less than 0.49 lb/ Mwh
  - Sound Emissions - less than 65dbA @ 10 meter (33ft)

Heating / Cooling Schools

Canton City Schools
C. T. Branin Natatorium
Microturbine Project

- Pool Heating-
  - 600,000+ gallons, approx.80F operating temp.
  - Unifin MicroGen- heat exchanger 20F rise, 40 gpm
  - Maintenance- Bi-Annual check of piping

Canton City Schools
C. T. Branin Natatorium
Microturbine Project

- Cooling
  - Air Condition Offices, Classroom, Hallway
  - Absorption Chiller- Cooltec 5 ton
  - Dual Fired- Waste heat and natural gas
  - Glycol solution, 10gpm, 45-55F temperature
  - Maintenance- Typical Annual System inspection

Costs

Engineering Costs	$9,700
Permitting Costs	$300
Microturbine	$80,000
Fluid Cooler	$5,000
Construction Cost	$70,000
Electrical Interconnection Cost	$500
Gas Interconnection Cost	$5,200
Heat Exchanger	$16,000
Misc Costs	$27,300
Total Costs	**$214,000**

CT = Energy Independence Act Distributed Resources

Incentives/Grants

- Customer Side Generation
  - $500/kW Southwest Connecticut*
  - $450/kW Remainder of Connecticut
  - Rebate of gas distribution charge
- Emergency Generation
  - $250/kW Southwest Connecticut*
  - $200/kWRemainder of Connecticut
  - Must enroll in ISO-NE Demand Response Program

*** Additional $50/kW only available for units operational before April 30, 2008**

New York = NYSERDA

- NYSERDA will support three types of projects: feasibility studies ($100,000 maximum subsidy), product development ($500,000 max.), and demonstrations ($1,000,000 max.). All proposals must be cost-shared at or above 50% (cash and in-kind), with preference given to proposals with higher contribution levels and higher cash portions of the contribution.

Vermont = CDEF

- **10 V.S.A. § 6523 (2006)**
- Vermont's Clean Energy Development Fund (CDEF) was established in 2005 to promote the development and deployment of cost-effective and environmentally sustainable electric-power resources -- primarily renewable energy and combined heat and power (CHP). The CDEF will receive annual payments of $6 million - $7.2 million from Entergy, which owns the Vermont Yankee nuclear power plant.

New Hampshire

- _____?
  - Net metering for very small residential renewable implementations.
  - Equal to 0.05 % of the demand.
    - Yes, that is 5 one-hundredths of a percent.

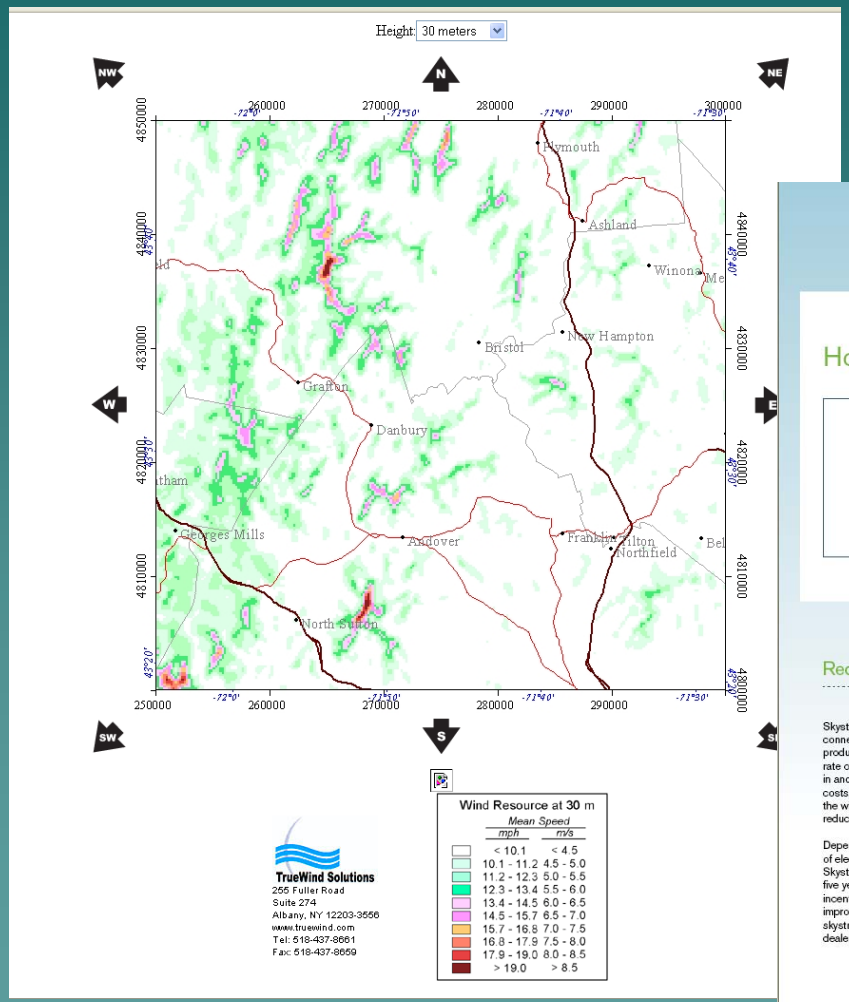
The Future

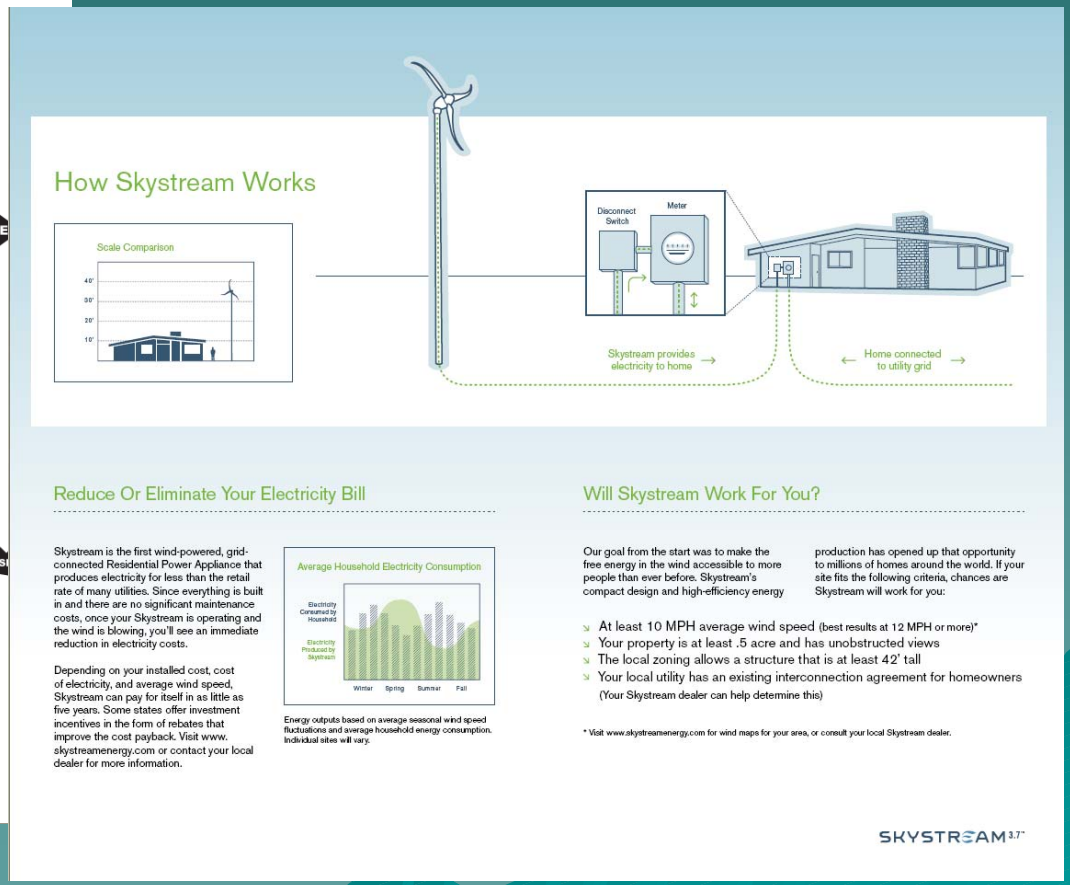
- Fuel Cells – new technologies.
  - Hydrogen.

- Solar.
  - Higher efficiencies.
  - Lower costs.

Wind

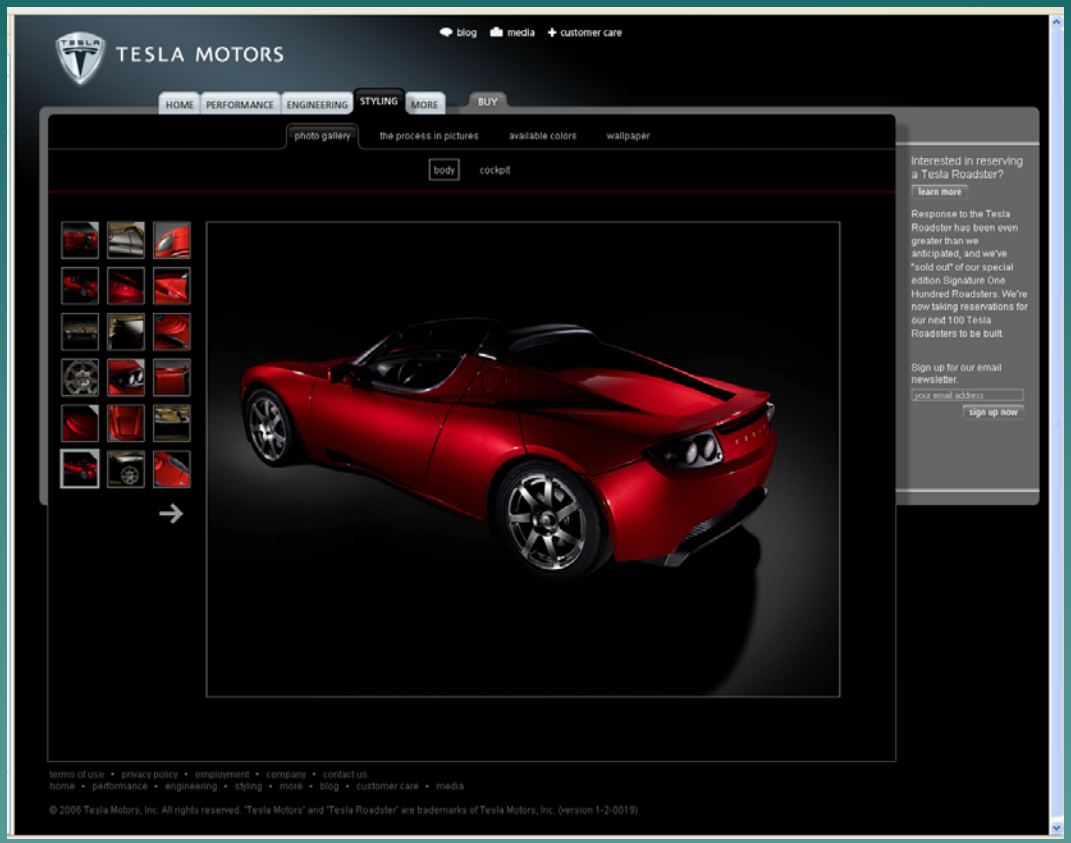
- Smaller.
- More efficient.





Back to the beginning.

- Think Distributed.
  - Solar.
  - Wind.
  - CHP.
- Made in America.
- The NH Advantage.
- Self-reliance.



- Doh!

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